

Steganocephalus (from Cat. Fa. Buda
* angle of mandible truncated

four digits webbed

no supraorbital groove

femur & tibia short & stout

phalanges long & slender

No tubercle on border of tibia

femur short, stout

glenoid with shallow dent. trochlear groove

femur with slight popliteal depression
" has pit post. & ext. to ectocondyle
skull has transverse fronto-nasal
ridge

Pseudodontornis & Palaeochenoides

OVER

The presence of a femur associated with the skull of P. stirtoni has made possible comparison with the type femur of Palaeochenoides and suggests that the Ushakov in separate suborder (Broderick 1963) is justified. shown in miocene. Parallelling the relationship described for the skulls and gross contours of the limb bones of Pseudodontornis and Osteodontornis (Howard, 1957:20) to those of Recent birds, the New Zealand femur shows a combination of albatrosslike and pelecani^{like}form characters. The Palaeochenoides femur is more distinctly pelecani^{like}form.

Suborder Cladornioide
Cyphornioidea

Cyphornis magnus ¹⁸⁹⁴
Tarsus L. Mro But Col.
see Wetmore 1928

Cladornis pachyphus ¹⁸⁹⁵
Tarsus L. O. S. Argentina

Palaeochenoides ^{miocenus} Shufeldt 1914
Tenu (dentus) L. M. So. Car.

Suborder Odontopterygia

Pelagornis micromus ¹⁸⁵⁷
Humerus N. M. France
580 mm (some resemble
Pinniped)

Odontopteryx foliifera ^{owen} 1873

SMALL skull L. Eoz. Euy.

Pseudodontornis longirostris ¹⁹³⁰

Osteodontornis orith ¹⁹³⁷

Suborder Sulae (longipennis Bonaparte)

← L. Tenuis → Argillornis emm ¹⁸⁵⁸
Humerus shaft L. Eoz. Euy.
also skull 190 mm.
Ulna 468 mm.

mailed
3/11
revised 1, 2, 2a,
7, 21 T 22a legends

A NEW SPECIES OF BONY-TOOTHED BIRD (FAMILY
PSEUDODONTORNITHIDAE) FROM THE TERTIARY OF NEW ZEALAND

By

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INTRODUCTION

A partial skull with jaws, referable to the extinct, bony-toothed odontopterygiform birds, has been found in New Zealand. The specimen, contained in a calcareous concretion approximately 155 mm x 120 mm x 100 mm in dimensions, was picked up in 1962 by Miss H. D. Adams, on Motunau Beach, 35 miles north of Christchurch, and was given to the Canterbury Museum of that city. The late Dr. R. A. Stirton, of the University of California, U.S.A., who saw the specimen while visiting the Canterbury Museum, recognized its similarity to Osteodontornis orri Howard, the bony-toothed bird of the Miocene of California. Subsequently, Mr. D. R. Gregg, Keeper of Geology at the Canterbury Museum, generously lent the specimen to the Los Angeles County Museum of Natural History for study. With his permission, it has been prepared by Mr. Leonard Bessom, of the Los Angeles Museum, revealing details of the palate, rostrum and jaws. A badly

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crushed femur, with fragment of acetabulum adhering, was freed from the matrix immediately adjacent to the right ramus of the lower jaw, and presumably belonged to the same individual.

Although many of the concretions found on the beach at Motunau are fossiliferous, the contained fossils, according to Mr. Gregg (personal communication) are mainly Mollusca, with some corals and crustaceans. Only one other occurrence of an avian fossil (the incomplete skeleton of a penguin) is known from the concretions. Marples (1960:185), who described the penguin, states: "The beach in this vicinity consists of boulders which are probably derived from the mudstone cliffs, where they occur as tabular concretions. The strata here are stated to be of Pliocene age, probably belonging to the Waitotaran stage." Wilson (1963:62-63) presents a list of the macrofossils (Mollusca and Cirripedia) from the coastal cliffs at Motunau as compiled by C. A. Fleming. He notes the occurrence of several forms characteristic of the Waitotaran-Nukumaruan (Upper Pliocene-Lower Pleistocene) boundary zone of the North Island, but adds that "Such species apparently moved northwards to characterize the Hautawan Substage (lower Nukumaruan) of the North Island, but their occurrence with Glycymeris manaiensis suggests that the beds at Motunau are no younger than mid Waitotaran." Mr. Gregg (pers com.) adds that, although it is probable that the concretion

containing the present specimen is from these coastal cliffs, it could have been derived from more distant deposits, as old as Lower Miocene (Otaian Stage). The geology of the Motunau area and environs is discussed in detail by Wilson (1963).

Mr. Gregg submitted a sample of the matrix from the present specimen to Mr. G. H. Scott, micropaleontologist at the New Zealand Geological Survey, Lower Hutt. Mr. Scott reports the presence of the following foraminifera: *Robulus* sp., 1 juvenile; *Karrerria* (?), 1 specimen; *Trifarina bradyi*, 1 specimen; *Bolivina* sp., 1 specimen. He states, "All specimens are tiny; this together with rather poor preservation, prejudices identification. As a guess I suggest that the sample is probably not lower than the Pareora Series (Lower Miocene); there is no good evidence for its upper limit."

COMPARISON WITH OTHER BONY-TOOTHED BIRDS

The bony-toothed birds are currently classified (Brodkorb, 1963:262) as a suborder, *Odontopterygia*, of the order *Pelecaniformes*. Previously recorded skulls are Eocene and Miocene in age as far as data are available; neither locality nor age is known for the type specimen of one of the three described species:

Family Odontopterygidae

Odontopteryx toliapicus Owen (1873), Eocene, England

Family Pseudodontornithidae

Pseudodontornis longirostris (Spulski) (1910), age and locality of type unknown; referred fragment of jaw from Miocene of east coast of U.S.A. (Hopson, 1966).

Osteodontornis orri Howard (1957), Miocene, west coast of U.S.A.; referred fragments from two other California Miocene localities (Howard and White, 1962, and Howard, 1966).

The New Zealand skull consists of a section anterior to the brain case, including the posteriormost portion of the rostrum, together with corresponding portions of the right and left lower mandibles. The specimen agrees with the skulls of all three of the previously described species in the characters diagnostic of the suborder Odontopterygia, namely, possession of bony teeth, straight frontonasal suture, and high, narrow rostrum bearing a longitudinal groove which ascends slightly from its point of origin at the preorbital vacuity (see Howard, 1957:19). In more detailed characters, the specimen at hand is clearly distinguishable from the type of Odontopteryx, the monotypic genus of the family Odontopterygidae, and conforms with the diagnosis set forth (Howard, 1957:21) for the family Pseudodontornithidae, *i. e.*, bony teeth vertically directed, zygomatic arch high, palatal region enlarged ventrally, lower jaw high posterior to mandibular suture, the suture relatively straight and nearly vertical in position, mandibular groove running longitudinally.

Family Odontopterygidae

Odontopteryx toliapicus Owen (1873), Eocene, England

Family Psuedodontornis longirostris (Spulski) (1910)

None of the characters enumerated as distinguishing the genera Pseudodontornis and Osteodontornis (Howard, 1957:3) can be assessed with certainty in the New Zealand skull. The important ratios of cranial length to skull length (greater in Pseudodontornis than in Osteodontornis), height of rostrum to cranial length (less in Pseudodontornis), and height relative to length of zygomatic arch (higher in Pseudodontornis) are not possible to ascertain; the rostrum is broken so that only a portion of the lower part of what may be the external naris is preserved on the left side, and the shape of the opening cannot be determined; ⁰owing to the incomplete tomial contour, it is impossible to tell whether the central palatal ridge would have been visible below the tomium at the naris as in Pseudodontornis; the teeth available are posterior to those for which measurements of "largest tooth" are given in the other two specimens; this posterior area of the jaw is obscured by matrix in P. longirostris, and in O. orri, the teeth, though present, are poorly preserved; the occurrence of several small processes between the more prominent "teeth" suggests closer similarity to the condition found in Osteodontornis, but the actual arrangement does not coincide with the incompletely preserved posteriormost processes in the type of O. orri.

Judging from the height of the rostrum and mandible, the New Zealand bird appears to have ^{been} smaller than either Pseudodontornis longirostris or Osteodontornis orri (see Table 1). Certain proportionate differences can be observed with respect to O. orri. The zygomatic arch is ~~actually, much less proportionately~~ higher,

the frontonasal hinge broader, and the space between the anterior edge of the orbit and the hinge (preorbital vacuity) is longer. Only one of these proportions can be definitely compared with P. longirostris: Spulski (1910:514) indicates the distance from orbit to frontonasal hinge in P. longirostris as 20 mm, which, although proportionately shorter than the New Zealand measurement of ^{21.0}~~20.7~~ mm, is closer than is the 15.8 mm measurement of O. orri. The measurement of breadth of the frontonasal hinge is not available in P. longirostris, but the rostral breadth anterior to this point suggests that the rostrum was broader than in O. orri, hence proportionately closer to the New Zealand specimen.

A striking similarity with Pseudodontornis is seen in the palatal area. The large, rounded central ridge on the ventral side of the rostrum, and the greatly enlarged palatines of P. longirostris, illustrated by Lambrecht (1930:pl. 1, fig. 2) are markedly paralleled in the New Zealand skull. Lambrecht's description, however, indicates that the palatines are vertically placed and that the bones of left and right sides are medianly united. In the New Zealand skull, the palatines flare ventrolaterally and there is no evidence of medial union, although the bones are very close together ^{dorsally and anteriorly}. Lambrecht also inferred (loc. cit.) that the maxillopalatines were visible and "separated by a chink in the middle line." As the matrix in P. longirostris was not completely cleared in the palatal area, the anterior continuation of the palatines may have been mistaken for maxillopalatines. In the New Zealand skull it has been possible to uncover the entire length of the palatines, revealing their highly unusual position, close together and medianly situated at their junction with the palatal surface of the premaxillae. A small, median

triangular projection from the premaxillae overlaps the palatines ventrally, but does not divide them.

Longitudinal sculpturing on the dorsal edge of the lower mandible, both medially and laterally below the orbit, is shown in the illustrations of P. longirostris (Lambrecht, 1930: pl. 1, figs. 1 and 2) but is not discussed. Lambrecht states, however, that there is no mandibular foramen. Similar sculpturing occurs on the mandibles of the specimen at hand, and, on the medial surface, forms a longitudinal depression which deepens anteriorly and constitutes what we interpret to be the mandibular foramen; this anterior area is obscured by matrix in P. longirostris.

Unfortunately, the details neither of the palatal area nor of the sculpturing of the dorsal edge of the lower jaw can be observed in the type of Osteodontornis orri. Distinctions of the New Zealand skull from that of O. orri are notable in the smoothly convex posterior contour of each side of the rostrum, longer preorbital vacuity, broader frontonasal hinge, and, in the lower jaw, discontinuance of the longitudinal groove well anterior to the mandibular suture. The lower contour of the mandible also seems to be more abruptly curved upward immediately anterior and posterior to the suture than in O. orri.

In view of the fact that the details that can be compared between the New Zealand skull and the type of Osteodontornis orri tend towards distinction, whereas those compared with the type of Pseudodontornis longirostris tend toward similarity, the New Zealand specimen is assigned to Pseudodontornis. The generally smaller size of the specimen, and the arrangement of the teeth indicate specific distinction. We take pleasure in naming the species in honor of the late Dr. R. A. Stirton, whose recognition of the relationships of the skull made possible this study.

DESCRIPTION

Pseudodontornis stirtoni, new species

Type: Incomplete skull and jaws in calcareous concretion; Canterbury Museum no. AV 20,569. Lying free on beach, and collected by Miss H. D. Adams, August, 1952.

Locality: Motunau Beach, 36 miles north of Christchurch, New Zealand; grid reference S69/403139, New Zealand Geol. Surv. Map, Waipara Subdiv., 1:63,360 (Wilson, 1963).

Formation and Age: Concretion probably derived from "Greta Siltstone," Waitotaran Stage, Pliocene.

Referred specimen: Poorly preserved left femur, found in concretion with skull.

Diagnosis: Tomia of skull and mandibles bearing symmetrically placed, slender, bony projections, of varying sizes, from minute spines to well-formed toothlike processes; palatine bones greatly swollen, diverging ventrolaterally (not vertical in position), very close together dorsomedially throughout their extent, but seemingly not united, narrowing anteriorly to join premaxillae in a median position; longitudinal groove of lower mandible not continued posteriorly as far as mandibular suture; size smaller than P. longirostris, more than 20 per cent less in height of rostrum and mandible, and 13 per cent in breadth of rostrum (see Table 1).

Description: As some portions of the skull are revealed in greater detail in P. stirtoni than in previously known specimens of the family Pseudodontornithidae, the description that follows is given in considerable detail. It is probable that some of the characters described occurred as well in P. longirostris and/or Osteodontornis orri.

TABLE 1
Measurements (in millimeters) of Skulls
of Pseudodontornithidae

	<u>P. stirtoni</u>	<u>P. longirostris</u> ^a	<u>O. orri</u> ^a
Rostrum			
Height at nares	29.0 approx.	36.0 ^b (124)	40.0 (138)
Height at fronto-nasal hinge	40.6	.....	47.0 ^c (115)
Breadth posterior to nares	44.0	50.0 ^b (113)	.....
Breadth of fronto-nasal hinge	35.0	.....	27.0 (77)
Distance from frontonasal hinge to posterior border of nares	73.0 approx.	90.0 ^d (123)	93.0 (127)
Lower Mandible			
Height at suture	43.8	.....	50.0 (114)
Height through pseudocoronoid process	50.0	.....	56.0 (112)
Height between suture and level of nares	24.7 approx	30.0 ^b (121)	32.0 (128)
Zygomatic arch			
Greatest height	14.0	17.5 ^b (125)	13.0 (93)
Palatines			
Greatest depth	31.0 approx.	40.0 ^d (129)	.....
Distance from orbit to fronto-nasal hinge	21.0	20.0 ^d (95)	15.8 ^c (75)

^a Figures in parentheses are ratios in percent relative to the same measurement in P. stirtoni.

^b Calculated from Lambrecht (1930, pls. 1 and 2)

^c Measured on cast of type; other measurements of O. orri as given by Howard (1957:9)

^d Measurements given by Spulski (1910).

Frontals

A section of the frontals anterior to the orbits, 37.5 mm. in anteroposterior length, shows the following characters: middorsal area depressed, frontonasal suture straight, paired nasal processes of premaxillae discernible both posteriorly and anteriorly to suture; no evidence of supraorbital grooves.

Lacrimals

The lacrimal bones are fused to the frontals. That of the right side has been revealed in some detail by preparation and extends roughly 33 mm. below the dorsal surface at a point 20 mm. posterior to the frontonasal suture. Characters are as follows: midway of its ventral descent, the bone broadens abruptly laterally, its outer border turning slightly upwards and posteriorly; dimensions at this point are 12.0 mm. breadth x 8.4 mm. anteroposterior depth; above this point dimensions are 7.2 mm. x 6.0 mm.; bone becomes thinner anteroposteriorly as it descends but continues to flare outwardly to a lateral dimension of 17.5 mm., the ventral border descending slightly to a pointed lateral tip; the median border is straight and there is no evidence of connection to the interorbital septum; the bone appears devoid of foramina.

Zygomatic Arch

The zygomatic arch on the right side is complete in contours for a distance of 65.5 mm. from its connection with the rostrum; that of the left side is less well preserved. Characters are as follows: a heavy bar 5-6 mm. thick, ranging in height from 7 mm. at its connection with rostrum to 14.0 mm. immediately anterior to lacrimal; external surface flat, with longitudinal groove near ventral edge; dorsal edge sloping inwards to form an obliquely thickened surface similar to that found in Sula.

Rostrum

The preserved portion of the beak is approximately 90 mm. in length from the frontonasal hinge, with tomium present for a distance of approximately 72 mm. on the right, 78 mm. on the left; greatest width posteriorly is 54.4 mm., tapering anteriorly to 44.0 mm at the broken end. Characters are as follows: dorsally, nasal processes of premaxillae in broad triangular-shaped depression, with apex approximately 22 mm. anterior to frontonasal hinge; anterior to depression middorsal area (11.5 mm. in width) flattened, with faint, bordering and central ridges; posterolateral contour of rostrum broadly curved; longitudinal groove present on lateral surface, 28.5 mm. distant from dorsal surface posteriorly and 16.0 mm. at broken anterior end; on left side, at broken edge, groove seemingly runs into external naris, bone turning medially at this point forms what appears to be the floor of the naris (upper border broken away); rostrum medially hollow in this area, although a few millimeters anteriorly, cancellous bone is present, apparently in situ; ventral surface of premaxillae with broad (16.5 mm.) median swelling extending to, or below tomial edge and separated laterally from tomia by deep longitudinal troughs (from the position of the lower mandibles on the specimen, it is assumed that the lower tooth processes fit into this trough when the jaws closed); posteroventrally, swelling terminating medially in small (5.5 mm. long) triangular process, underlying anteriormost tip of palatines; laterally swelling continuing alongside palatines for a distance of at least 26 mm. (matrix obscures the area beyond this point).

Palatines

The specimen had been subjected to pressure from the left side so as to thrust the lower mandible against the palatines and shift them to the right of the central line. The articulation with the pterygoids is broken and the posterior borders of the palatines lie about 20 mm. anterior and ventral to the stubs of the pterygoids that still adhere to the ^{para}nasal rostrum. The dorsal aspect of the palatines is still embedded in hard matrix, but the posterior half of the left side has been uncovered sufficiently to discern the dorsal and posterior contours; and, in ventral aspect, both palatines can be observed in considerable detail for their entire length (102.3 mm.). The following characters are noteworthy:

Right and left prepalatine processes narrow at anterior tips (approximately 2.5 mm. each) and close together in median line (6.4 mm. breadth across both bones); each process at least as deep, possibly deeper) dorsoventrally, as broad laterally, and seemingly forming a movable joint within the greatly inflated ridge of the premaxillae. Posteriorly, palatines gradually becoming inflated laterally and deepened dorsoventrally to maximum dimensions of 13.0 mm. thickness x 31 mm. (approximately) depth, at a point below the pre-orbital vacuity; narrowing again further posteriorly to 6.5 mm. in lateral dimension before expanding to the pterygoid articulation (12.2 mm. breadth). At greatest inflation, right and left bones widely separated ventrally, with dorsal, thinner portions sloping towards each other medially, where, before distortion, contact was presumably made with the parasphenoidal rostrum (area obscured by matrix); thin dorsal portions terminating about 10 mm. anterior to pterygoid articulation; at this point, smooth medial surface of left palatine suggests that right and left bones were not united dorsally. Surface ~~for~~ articulation with pterygoid ^{crescentic} ~~subcrescentic~~ in shape, with two well-formed articular facets —————→

(observable on left palatine; right and left palatines distinctly separate at articular end.

Lower Mandible

The section of lower mandible preserved is approximately 153 mm. long on the right side and slightly less on the left, with ^{intraramal} the suture visible on both left and right sides. Characters are ^{hingelike,} as follows: suture nearly vertical, [^] suggestive of that found in Sula, but seemingly even more mobile (lacking indication of a ventral piece extending across suture line from anterior to posterior areas); surangular visible both externally and internally across dorsal surface; two distinct lateral flanges on anterior side of suture overlapping posterior edge externally, one approximately 8 mm. above ventral edge, the other 15 mm. higher; thickness of mandible at suture, 12.6 mm.; with respect to rostrum, mandibular suture well forward of frontonasal hinge, hence markedly anterior to position found in Sula or any other living member of the Order Pelecaniformes, but similar to that found in Osteodontornis orri; posterior to suture, dorsal contour rising to high, rounded point as noted in Osteodontornis and referred to (Howard 1957:9) as the coronoid process (probably, however this process is not homologous to the coronoid as its position is well anterior, rather than posterior to the orbit); posterior to this "pseudocoronoid" process, groove on medial side dorsally deepening anteriorly to form what appears to be the mandibular foramen (partially obscured by matrix); another distinct oval foramen present medially near lower edge of ramus just posterior to mandibular suture; dorsolateral edge posterior to pseudocoronoid thickened and bearing heavy parallel ridges; longitudinal groove discernible on external surface 15 mm. anterior to suture and extending forward, distinguished from condition in Osteodontornis in which groove begins at suture); ventral contour of jaw dipping downward at suture, rising anteriorly and posteriorly thereto.

"Teeth" (Plates 2 and 3)

Tooth processes occur in both upper and lower jaws. As in the other described species of Odontopterygia, the processes are continuous with the bone of the jaws and, on one or two, the tip is broken, revealing the hollow structure. In the upper jaw, the "teeth" are broken away on the left side. Those on the right are poorly preserved but serve to determine the position of the posteriormost process (which appears to have been very small) approximately 20 mm. anterior to the posterior edge of the rostrum, and to demonstrate the arrangement of large and small processes along the 35 mm. tomial contour to the broken end of the jaw. Following the first process, there are three well-defined "teeth" spaced only 10 mm. apart, from center to center, with smaller processes between. The anteriormost "tooth" is notably larger than the others, with a base of more than 7 mm. and height possibly 10 mm.

On both lower rami the five posteriormost "teeth" are present, and, on the right ramus, where the matrix has not been removed from their outer surfaces, they are well preserved. The posteriormost "tooth" process (approximately 6 mm. high x 3 mm. across the base) is almost on the intraramal hinge line; this is followed by a more slender process (5 mm. x 1 mm.) a larger one (10.3 mm. x 5.7 mm.) and another slender one (7 mm. x 2 mm.). The fifth, and largest measures 14.3 mm. in height and 5.7 mm. across the base. It should be noted that, except for process 1, these "teeth" are preserved to a pin-sharp tip, thus providing a more complete height than it has been possible to observe in previously known specimens; comparison of the height of the largest "tooth" of the right ramus with the same "tooth" on the left ramus (on which the tip is rounded

off as in previous specimens) suggests the difference that degree of preservation may make in accuracy of measurement, i. e., height of right "tooth", 14.3 mm., height of left "tooth", 11.3 mm. Ridgelike spines occur between the well-defined processes, but are best discerned in external aspect, as seen on the left ramus. The distance on the lower jaw occupied by the five processes is 39 mm.; three additional broken processes can be distinguished on the right ramus in the 19.6 mm. space anterior to the fifth "tooth". We estimate that when the jaws were closed, the largest lower tooth process preserved was slightly anterior to the largest upper; this would bring the posteriormost process of upper and lower jaws about on a line, the lower possibly slightly anterior to the upper.

In both P. longirostris and O. orri, the largest "teeth" measured (both upper and lower) were well anterior to the external nares. The corresponding processes in P. stirtoni could, therefore, have been 10-20 mm. anterior to those which are preserved.

Femur (Plate 4)

The badly crushed and eroded femur measures 129.5 mm. in length, externally, with a maximum distal breadth of approximately 31 mm.; the shaft has a lateral breadth of 13.6 mm. at the center; it is impossible to take an accurate anteroposterior measurement. Although the crushing of the shaft reveals the thin wall of the bone and interstitial supports, it disguises any possible evidence of external pneumatic foramina. Characters of the femur are as follows: shaft slender, straight as viewed posteriorly, but slightly curved as viewed laterally, with convexity towards anterior face; posteriorly, proximal tips of both

external and internal condyles distinctly set off from shaft, and, on the external side, curving proximally beyond base of condyle; intercondylar area wide, and markedly excavating median contours of both external and internal condyles posteriorly; rugose, raised surface for tendinal and muscle attachments extending along posterior edge of shaft above fibular condyle to a distance of 35.3 mm. from distal tip of bone, with proximalmost portion (a surface 9 mm. x 4 mm. in dimensions) encroaching onto posterior face of shaft; flat oval muscle scar still farther proximad (41.8 mm. from distal end) on external face of shaft anterior to rugose area; posteriorly, area above each condyle flat except for small depression above fibular condyle (it is not clear whether the depression of the intervening popliteal area is natural or due to crushing); external side of bone above fibular condyle sloping medially, suggesting a very shallow rotular groove, but as neither condyle is complete anteriorly, the condition of this area cannot be ascertained with certainty.

In general contour of the bone, upturned tip of external condyle, and height and position of rugosities above fibular condyle, the fossil resembles the femur of Diomedea, although the prominence of the lower portion of the rugosity is also suggestive of Pelecanus. ^{median contours of the condyles, posteriorly, in the} The excavation of the [^]intercondylar area is in marked contrast to the condition in Pelecanus, and is even greater than in Diomedea. In the position of the lateral muscle scar and the forward slope of the bone external to the fibular condyle, the fossil more closely resembles Pelecanus. The internal condyle appears to be more deeply rounded in contour and more posteriorly protruded from the shaft than in either of these Recent genera in which the species attain large size.

Through the courtesy of Dr. James Hopson and Dr. E.L. Simons of Peabody Museum of Natural History, Yale University, it has been possible to examine a cast of the type distal end of femur (1916) of Palaeochenoides mioceanus Shufeldt from the Miocene phosphate (Hawthorne formation) beds of South Carolina, a large aberrant member of the Pelecaniformes allocated to the extinct family Cyphornithidae. (Wetmore, 1928:4) The discovery of a fragment of bony-toothed lower jaw in the same formation as the Palaeochenoides femur led Hopson (1964:16) to raise the question of possible synonymy of Pseudodontornis with Palaeochenoides. Comparison of the New Zealand femur with the type of Palaeochenoides indicates that, if we are correct in assuming that the femur belongs with the skull of P. stirtoni, Pseudodontornis and Palaeochenoides are distinct genera. The type of Palaeochenoides mioceanus, which is almost 30 per cent larger than the femur of P. stirtoni, is a more inflated bone, with proportions suggesting a gigantic pelican as contrasted with the straighter, slimmer albatross femur which P. stirtoni more nearly resembles. Further characters that distinguish P. stirtoni from Palaeochenoides mioceanus are: intercondylar area posteriorly more excavated along median edge of condyles; tip of external condyle extended upward posteriorly above flattened shaft (tip of condyle missing in Palaeochenoides but shaft immediately above is raised, not flat); muscle rugosities along external edge more posteriorly placed and extending relatively higher; rotular groove possibly more flattened.

In Hopson's study (1966) of the fossil, from the Miocene Hawthorne formation of South Carolina, he^{tentatively} assigned a tarsometatarsus (Mus. Comparative Zoology no. 2514) to Palaeochenoides mioceanus, largely on the basis of its general agreement in size to the type femur of that species from the same formation. He noted, however, the albatrosslike qualities of the tarsometatarsus as distinguished from the pelecaniform characters of the femur. The present study of the femur of P. stirtoni in which the distinctions from Palaeochenoides parallel those which Hopson observed in the tarsometatarsus no. 2514, suggests that the tarsometatarsus more likely relates to the Pseudodontornis jaw found in same formation than to the Palaeochenoides femur.

DISCUSSION

The Order Pelecaniformes is well known as a heterogeneous assemblage, and the skulls representative of the various families reflect this heterogeneity. The most outstanding skull characters typical of the order are: reduced or obsolete nares (except in Phaethon), united palatines (except in Phaethon), and straight craniofacial hinge (least developed in Fregata).

Knowledge gained of the preserved portion of the P. stirtoni skull adds considerably to what was known previously of the pseudodontornithid skull as revealed in the types of P. longirostris and Osteodontornis orri. Combining the details revealed in the three specimens, it is possible to make some significant comparisons with skulls representative of families of living pelecaniform birds.

In overall configuration the pseudodontornithid type of skull resembles most that of Pelecanus. The long bill, relatively short postorbital portion of the cranium, long mastoid processes, descending palatines, and forward sloping quadrates are points of similarity, as well as the straight craniofacial hinge. Distinctions are largely associated with the most notable character of the fossil group, the bony tooth processes, which are concomitant with a generally heavier skull. The slender, flexible lower mandible of Pelecanus is replaced in the fossils with very heavy ramus. The rostrum, too, is heavier, as are the zygomatic arches and the palatine bones. Whether or not the aperture on the rostrum was functional as an external naris is not yet determinable. The suggested hollowness of the rostrum in P. stirtoni, seemingly associated with evidence of external nares, cannot be demonstrated as an air passage, although the possibility cannot be dismissed;

DISCUSSION

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it might, as well, have served merely to lighten an otherwise very heavy beak.

The character of the lower jaw can be more closely identified with the condition found in the boobies and gannets than in the pelicans or any other pelecaniform bird. In Sula, flexibility is achieved by an intraramal hinge. Through the courtesy of Dr. Kenneth Stager and Mr. James Northern of the Los Angeles County Museum of Natural History, a ~~fresh~~ specimen of Sula neboxii was made available for study. Manipulation of the jaws of this specimen allowed expansion at the level of the intraramal hinges of nearly 200 per cent (from a breadth of 12 mm, relaxed, to 35 mm, expanded), without exertion of undue force. The intraramal suture as revealed in the New Zealand fossil, like that of Sula, is a hingelike joint, and, as it appears to lack a connecting bone at the lower contour, may have been even more expandible than in the living sulids.

In the structure of the palatines and the mobility between these bones and the rostrum there is no member of the Pelecaniformes with which to compare the fossil group. The palatines in all modern pelecaniforms, although posteriorly united (except in Phaethon), are separate anteriorly, forming a rather broad area of fusion with the premaxillary mass. At this end the palatines (prepalatine processes) are invariably dorsoventrally flattened, and bending occurs here within the palatines upon movement of the upper jaw. The thickened Pseudodontornis palatines, as now revealed in P. stirtoni, lack this flexibility. Although there is no visible evidence of fusion, they remain adjacent along their entire length, narrowing anteriorly almost to a point and passing together into the greatly enlarged central premaxillary mass, where they may be hinged as are the palatines in the Psittaciformes.

use as "caution"
copied

Although the pseudodontornithid skull type presents in varying degrees a number of similarities to other pelecaniform types, its singular combination of those features, plus its own unique characteristics, set these "hook-toothed" birds apart from all other pelecaniform types. The intramammary hinges present in pseudodontorns and sulids probably represent independently acquired convergent features adapted to allow significant mobility within an otherwise "inexpandible" jaw. The similarities in conformation between pseudodontorn and pelecanid skulls may represent either parallel evolution from, or convergent evolution towards a common long-billed skull type.

DISCUSSION

The Order Pelecaniformes is well known as a heterogeneous assemblage, and the skulls representative of the various families reflect this heterogeneity. The most outstanding characters of the typical of the

SUMMARY AND CONCLUSIONS

uses as carbon
Ogden

A partial avian skull and femur, found in a Tertiary (presumably Pliocene) concretion in New Zealand, represent an odontopterygian bird approximately twice the size of the Eocene Odontopteryx toliapicus, ^{from England} but smaller than Osteodontornis orri from the Miocene of North America, or Pseudodontornis longirostris (age and locality of type unknown; referred jaw from the Miocene of North America).

In spite of the incomplete condition of the skull of the New Zealand specimen, it has been possible to uncover certain areas not observed in detail in previously described skulls of the bony-toothed birds, notably the full length of the large palatine bones, one complete lacrimal, details of the intraramal hinge, probable location of a mandibular foramen, and the sharp-pointed tips of unworn teeth. The associated femur has provided the first opportunity to examine this element of the Pseudodontornis skeleton in comparison with the type of the genus Palaeochenoides, and has demonstrated their generic distinction.

The additional information contributed by the newly revealed characters serves to emphasize the uniqueness of the group of bony-toothed birds. Howard (1957) concluded, after studying the nearly complete skeletal impression of Osteodontornis orri, that the group showed resemblance to both the Procellariiformes and the Pelecaniformes, but diverged sufficiently from Recent birds to warrant recognition of ordinal status. Wetmore (1960:8) after reexamination of the type skull of Odontopteryx toliapicus, felt that the pelecaniform characteristics were predominant and that resemblances to the Procellariiformes might "be subject to other interpretation." Recognizing the uniqueness of the group, however,

he proposed subordinal status within the Order Pelecaniformes.

The divergence of characters among the different families of living pelecaniform birds has been noted. Allocation of the bony-toothed birds to this order adds another facet to the heterogeneity of the group. The most outstanding distinction revealed by the present study is the thickness of the palatines and their narrow, median junction with the premaxillary mass, presumably in the form of a hinge joint; certainly ~~not a flexible bending of~~ the prepalatine processes themselves ^{are not flexible} as in all other pelecaniform birds. Whether or not this character was distinctive of the entire suborder, including both the Odontopterygidae as well as the Pseudodontornithidae, cannot be determined as the palatal structure of the former family is not known.

The New Zealand specimen marks the seventh reported recovery of bony-toothed avian jaws from widely separated areas. Its characteristics compared with the type specimens of the three previously described species distinguish it as a separate species, but indicate generic similarity with Pseudodontornis longirostris. It is here described as Pseudodontornis stirtoni. If, as evidence indicates, the concretion containing this specimen is from the Pliocene ^{of the cliffs immediately adjacent to the beach} Greta siltstone, the known range of the bony-toothed birds is extended geologically as well as geographically: Eocene-Pliocene; Europe, North America, New Zealand.

ACKNOWLEDGMENTS

We wish to express our gratitude to Mr. D. R. Gregg, Keeper of Geology, Canterbury Museum, Christchurch, New Zealand, for lending this significant specimen, and for his generous assistance throughout the study in supplying information concerning the geology of North Canterbury. We want also to acknowledge our indebtedness to the late Dr. R. A. Stirton, former Director of the Museum of Paleontology, University of California, for his part in bringing the specimen to our attention. We are grateful to the Los Angeles County Museum of Natural History for affording us office and laboratory facilities, and the assistance of staff personnel.

The photographs were made by Mr. Mike Hatchimonji, Senior Photographer, and retouched by Miss Mary Butler, Graphic Artist, both of the Los Angeles Museum staff. The cost of preparation of the specimen by Mr. Leonard C. Bessom, Senior Preparator of the Los Angeles museum, was shared by the Canterbury Museum.

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Legends for illustrations

Plate 1. Type skull of Pseudodontornis stirtoni, n. sp.

Upper: right lateral view. Lower: left lateral view.

Figures approximately 3/4 nat. size.

Plate 2. Type skull of Pseudodontornis stirtoni, n. sp.

Right dorsolateral view, retouched. X 1.

Plate 3. Type skull of Pseudodontornis stirtoni, n. sp.

Palatal view; retouched. X 1.

Plate 4. Referred left femur of Pseudodontornis stirtoni.

Left to right, anterior and posterior views. X 1.

(Portion of pelvis adhering to femoral head).

Key to Plate 2. apm, anterior portion of mandible; f, frontal;

fnh, frontonasal hinge; irs, intraramal suture;

l, lacrimal; mf, mandibular foramen; mg, mandibular groove;

npp, nasal process of premaxillary; ppm, posterior portion

of mandible; pt, pterygoid; rg, rostral groove;

tp, tooth process; za, zygomatic arch.

Key to Plate 3. apm, anterior portion of mandible; irs, intra-

ramal suture; pa, palatine; pnf, pneumatic foramen;

ppm, posterior portion of mandible; pr, palatal ridge

of rostrum; psr, parasphenoidal rostrum; pt, pterygoid;

sr, subrostral trough; tp, tooth process; ut, upper

tonium; za zygomatic arch.

Suggested 6 views of New Zealand skull to
be photographed. Photo order submitted Sept. 2, 1966
for delivery October 1, 1966.

- 1 Lateral view of left side jaw removed. (?)
- 2 Palate lateral view from left side to show
inside right ramus and $\frac{3}{4}$ view of palatines
- 3 Lateral view right side
- 4 Postero-dorsal view (show fronto-nasal hinge,
posterior side of lacrimal and foramen on
inside of lower jaw,
- 5' Ventral view (show palatines & ridge under
rostrum)
- 6 Antero-ventral view with left jaw in place.

9.13.64

Comparisons of meas. NZ vs O. ori & P. longirostris

Rostral area	NZ	O. ori	P. longirostris
Breadth front. nasal suture	32.5 (35.0?)	27.0	24.5?
Breadth at lacrymals	46.7	—	—
Breadth rostrum greatest (post) least (ant) but pat to nares	54 44	—	50 ant to nares
Depth rostrum	40.6	47.0	—
Posterior most to l. n. at nares	29 at rostrum tip	40	36
" " thru palat.	29.7	—	38.1 (40?)
Depth dorsal edge rostrum to sulcus (post.)	29	33	—?
Depth, sulcus to termin back nares	12.7 11.7	18.0	15.1 21.7
Zygoma	14.0	13.0	17.1
Ht zygoma	14.0	13.0	17.1
Palatal area	36.0?	—	40
Gr. ht.	12.2	—	10
Pr. pterygoid artic	102.3	—	7
Total length palatines	102.3	—	48.0
Lower mandible	43.8	50	56.6? let
Ht at suture	50.0	56	24.7 96 mm ant to suture
Ht 32.0 mm ant. to suture	24.7	24.7 30 mm ant to suture	24.7
Teeth (lower)	—	—	14.2 x 8.5 (ref. spec.)
A ant. most of O. ori type	—	—	" larger than A (ref.)
A ant. most of O. " referred	—	—	A or B 13.4 x 1.3
B 2nd	—	—	—
B 3rd	—	—	—
D last layer on NZ fossil	14.3 x 3.7 (x) 10.6 x 4.5 (y)	13.8 x 10.0 7 x 3.3 x 5.8?	B or C 17 x 15
Distance bet teeth	21	—	—
Center C to center D	22+	44.6	—
Length from post. end palatines through 1st large upper tooth	116	—	—

37.0 A to A
A to B
31.4 A to B
B to C
150 25.5 B to B
center

Measurements and Proportions of Skulls of
Bony-toothed Birds

Copied

	New Zealand skull	Pseudodontornis longirostris	ratio NZ to N.2	Osteodontornis orri	ratio NZ to N.2
5 Height of lower mandible at suture O	43.8 mm.	—	—	50.0	114.20
X Height of lower mandible immediately posterior to level of nares O P	24.7 (post & nares)	30 + ^a	121 +	32.0 (post & nares)	128 ^a / ₁₀
4 Height of lower mandible at posterior process O	50.0	.....	—	56.0	112
3 Breadth of rostrum just posterior to nares X P	44	50 ^b	113	.....	—
4 Breadth of fronto- nasal hinge O Z	35	...	—	27	77
2 Height of rostrum at fronto-nasal hinge O W	40.6	.....	—	47.0	115
1 Height of rostrum just posterior to nares O Y	29.0 (into nares)	36 (at nares)	124 x	40 (at nares)	138
9 Greatest depth of palatines	36.0	40	111	.....	—
* Height of zygomatic arch O P	14.0	17.5	125 x	13.0	93
10 Distance from orbit to frontonasal hinge O P	20.7	20.0	96.5	15.8	76.5

Pl to br. rostrum yx 66.0

72.5

Pl to br frontonasal hinge yz 83.0

148

6 Calculated from Samuels PL 2 pg. 1

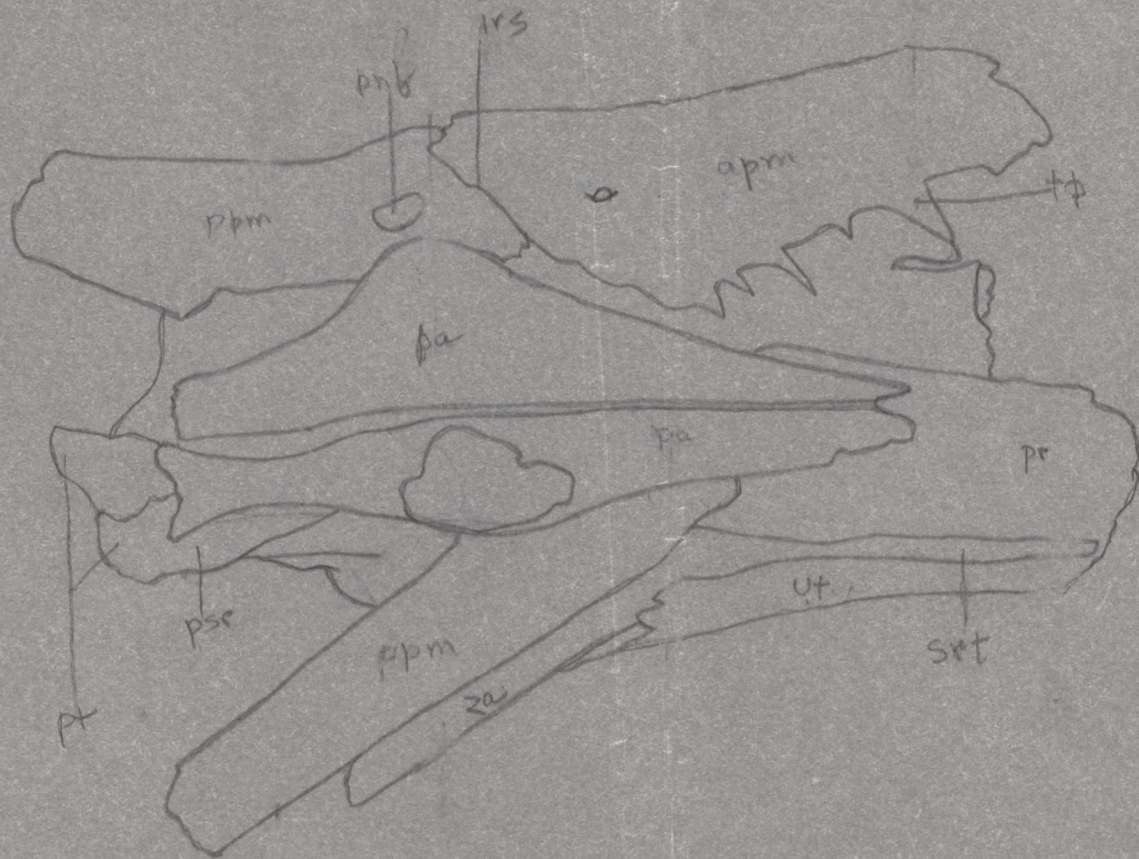
^c measurement from nares
As the rostrum tapers anteriorly, the measurement
at the level of the nares would be slightly less

a As the jaw tapers anteriorly, the measurement taken from the
greatest vertical dimension of the jaw fragment figured by Samuels
was as the measurement taken from the orbit to the frontonasal hinge
probably anterior to area measured in the other two skulls. ~~base~~
comparable position would probably provide a measure
close to that of O. ori.

meas of femur (N Z) of Dec. Bona

	NZ	P. mircaus	Chauna	Pelecanus	Diomedea	Cymus
① distal tip of ext condyle (NOT the fibula) to top of muscle scar on ext. side	35.3 (80% of P. mircaus)	40.0	Noscar ulna	31.0 22.7	23.0 27.4	1.174
② From same distal spot as in ① to top of lowest muscle scar on ext. side	29.4	34.0? diff. average.	20	16.9	22.4	
③ From same distal spot as in ① to top of muscle scar on ext. side but anterior to those meas'ns	42.0 (80% of P. mircaus)	51.0	20	29.5	38.0	
④ ① & ② Depth int. cond.	18.0	25.8		20.6	19.9	
⑤ Breadth across ext. and ext condyles (NOT including fibular cond.)	24.8 (76% of P. mircaus)	30.4 33.2	21			
⑥ P. dist. end	30.0	40.0		24.3	23.7	
⑦ Ht. ext. condyle to prox. tip	19.3	21.?	14.7	14.0	14.8	
⑧ Ht. int. condyle	15.3	20.0				
⑨ Dist. edge to ext edge summed above condyles (posteriorly)	26.2 (80% of P. mircaus)	34.8 34.3	20.7	22.0	22.3	
⑩ Least br. of shaft (mid)	14.10	20.6 20.4 rem. dim?	11.7	10.6	10.5	
⑪ Overall ext. length to artic. facet prox.	129.2 20% longer than Diab. batman	149-169? <u>160.2</u> dist. if part present 5 1/2 ext. band on	95.2	94.9	106.4	
⑫ Ratio 7/8	10.7	12.7?	12.3%	11.2%	9.9%	
⑬ Lateral dimension of prox. end	27.4?		23.4	23.5	22.2	
Ratio 9/8	21.2%		24.6%	24.8%	20.8%	
Ratio 4/8	18.5%		22.0%	21.8%	18.7%	
4/7						

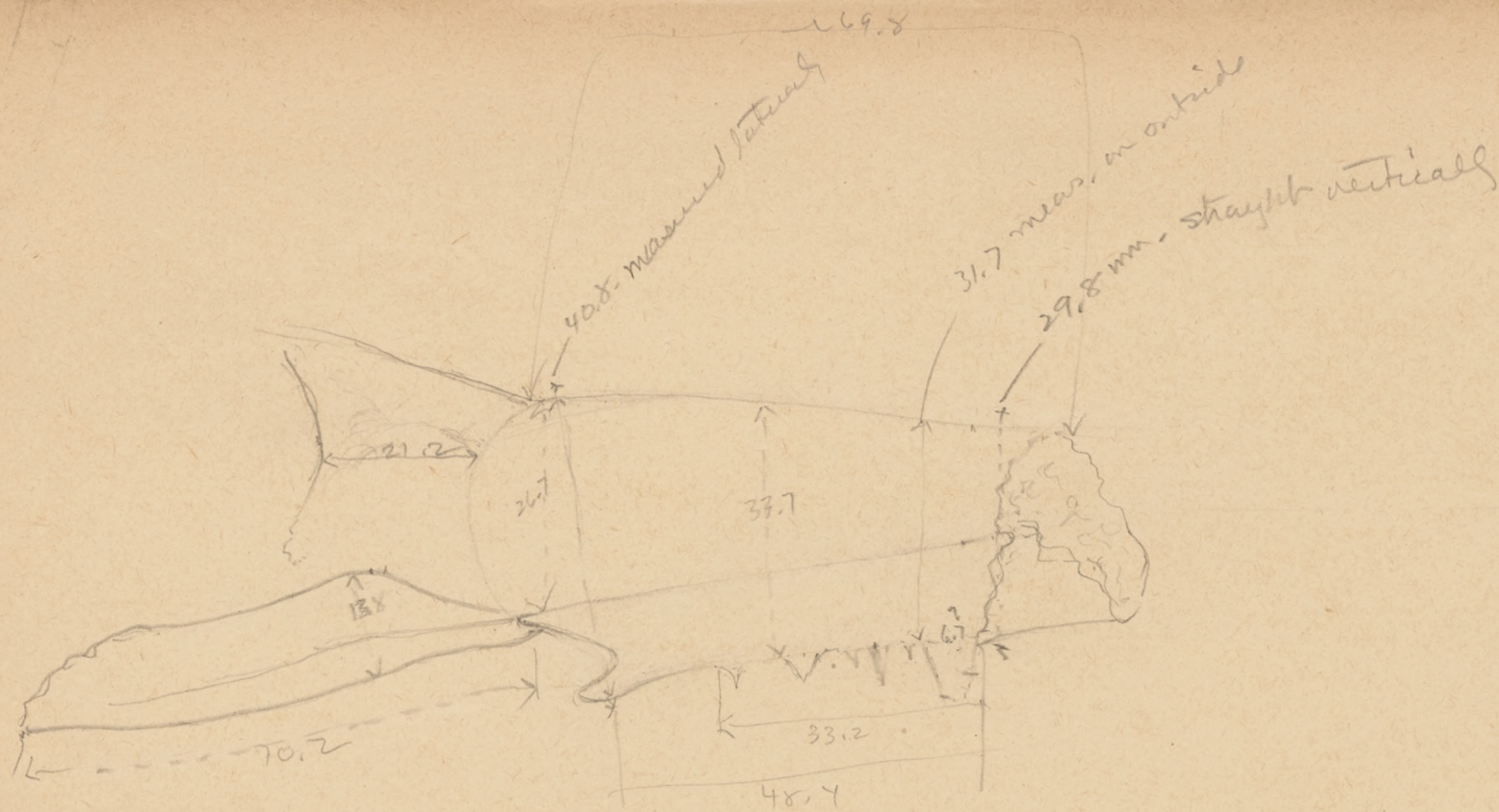
		Dorsolateral
Palatal		Dorsomedial
apm ✓	apm ✓	anterior portion of mandible
	f ✓	frontal
	fnh ✓	frontonasal hinge
irs ✓	irs ✓	intraramal suture
	l ✓	lacrimal
	mg ✓	mandibular groove
	mf ✓	mandibular foramen
	npp ✓	nasal process of premaxillary
pa ✓		palatine
pnf ✓		pneumatic foramen
pr ✓		palatal ridge of rostrum
z/ ppm ✓✓	z/ ppm ✓✓	posterior portion ^{of} mandible
psr ✓		parasphenoidal rostrum
pt ✓	pt ✓	pterygoid
srt ✓	rg ✓	rostral groove
tp ✓	tp ✓	subrostral trough
vt ✓		tooth process
za ✓	za ✓	upper tomium
		zygomatic arch



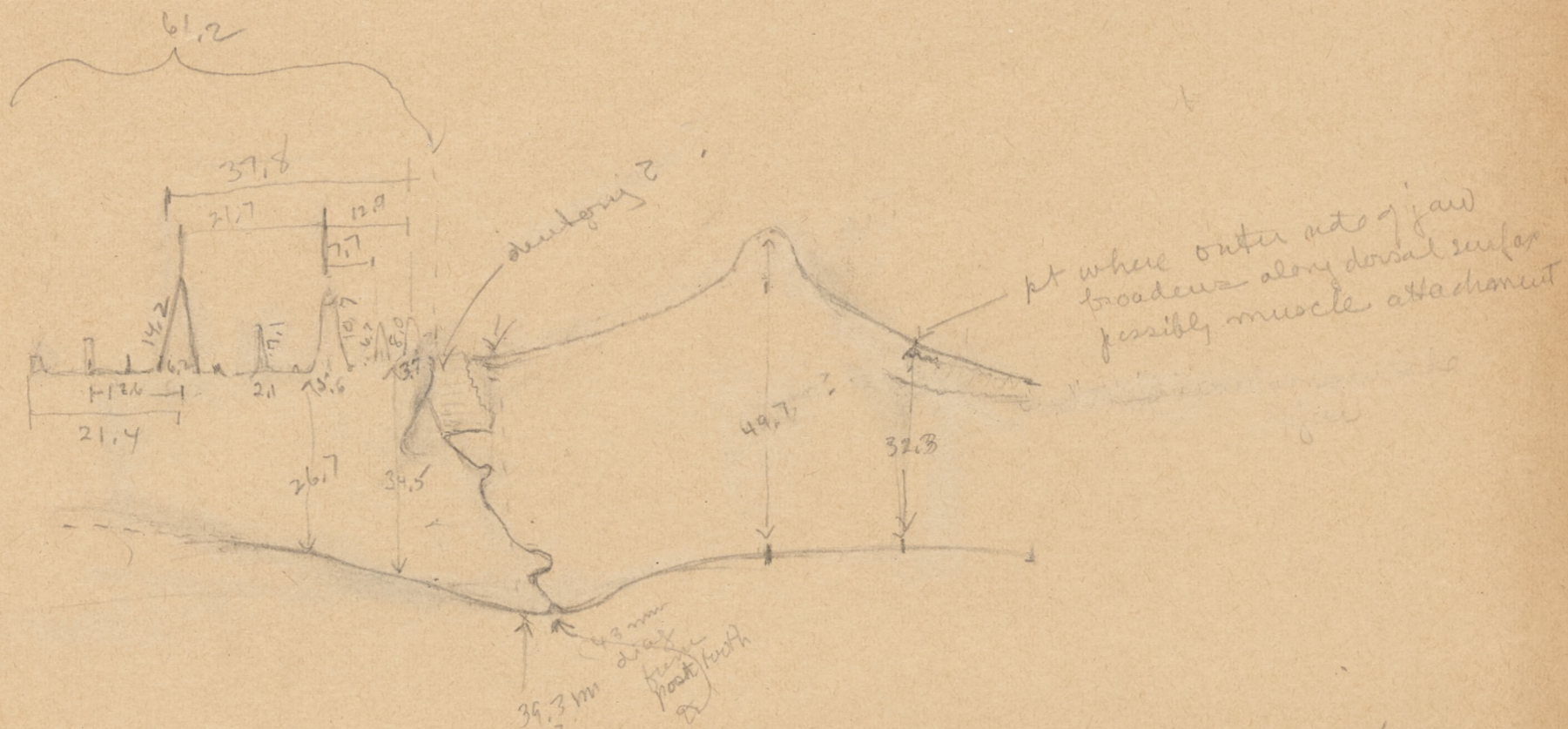
Key to Plate 3



Keep to Plate 2



New Zealand skull



Lower Mandible (reconstructed by studying both R & L sides)
New Zealand specimen

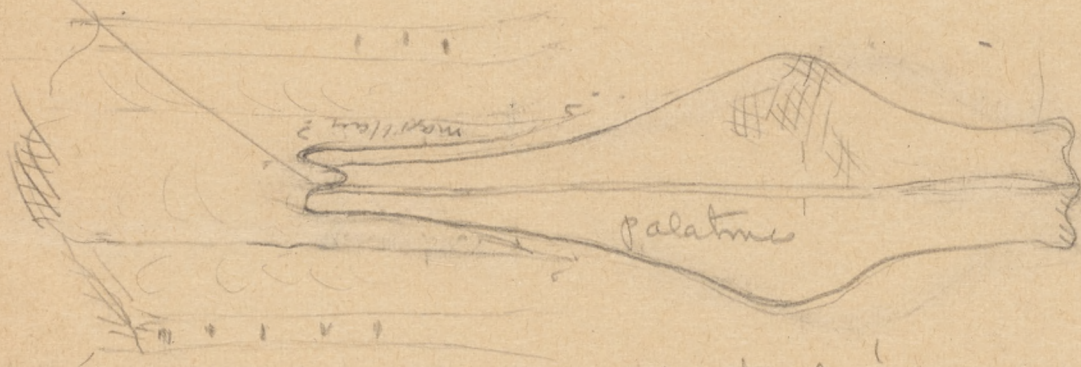
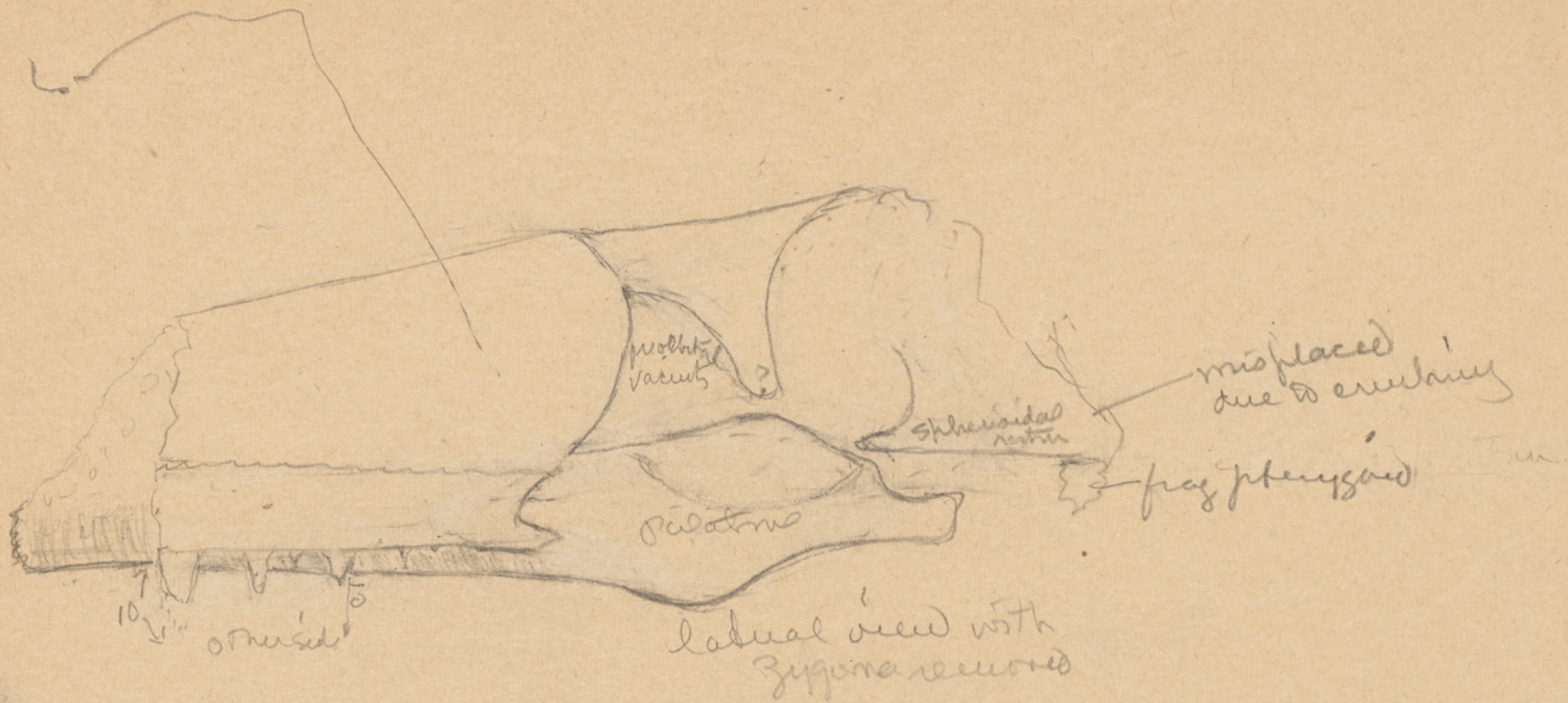
8.15.66 See later drawing Sept 1966
better representation



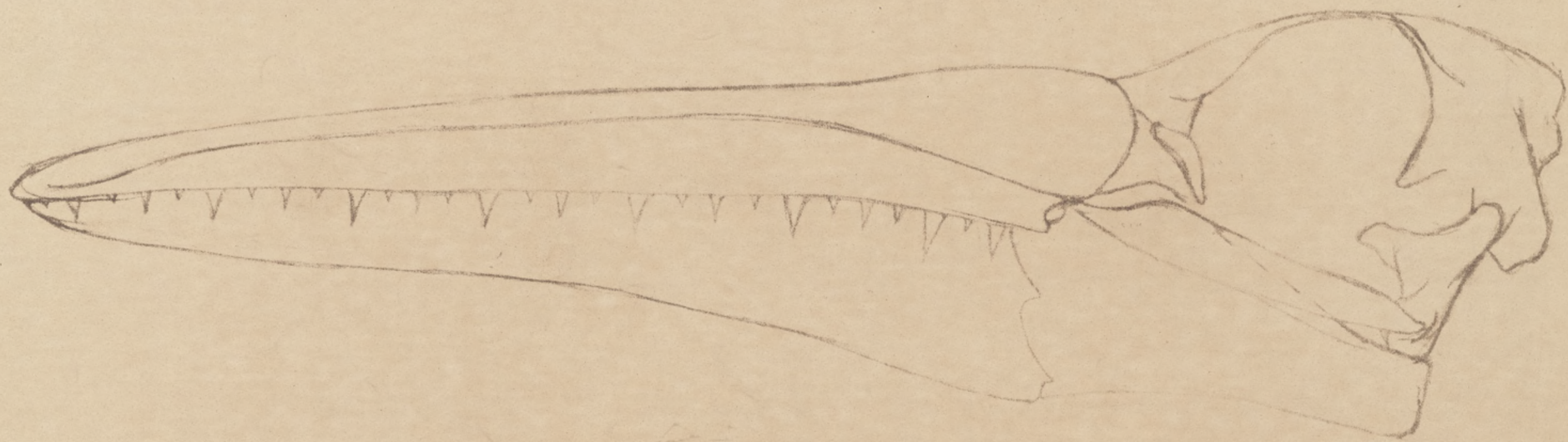
Discussion

In describing the NZ bird as a species of the genus Pseudodontornis we have chosen ^{the} one of three possible decisions, that seems to us both practical ^{most valid} as we have indicated above (ms pp. 3-5) characters significant in comparison with one of the previous genotypes (Pseudodontornis longirostris + Osteodontornis) cannot be checked on the other, and the generic ^{distinctions} between Pala, or other previously ~~described~~ ^{summarized} (Howard 1957: 3) are not clearly indicated on P. stintoni. Even the ~~cannot be measured~~ similarities to P. Pala Pseudodontornis, stating that they appear to be, ~~are~~ ^{would be} open to question ~~by those who~~ ^{do not} accept Sauvage's ~~statement~~ ^{that Sauvage's} statements regarding ~~the~~ ^{in P. longirostris} ~~that specimen~~ ^{was} based on incomplete preparation of the ~~other possible~~ ^{possibilities} ~~that courses~~ ^{that were taken} into consideration were

Three possible decisions ~~could be~~ ^{could be} made with regard to the NZ bird: ① ^{its difference from P. r. o.} ~~were distinct enough to~~ generic value; ② it was sufficiently like both Pseudodontornis longirostris + Osteodontornis ~~to~~ ^{to suggest that all three were only specifically} ~~reparable~~ ^{reparable}; ③ it showed more characters similar to Pseudodontornis longirostris and should be assigned to that genus. ~~This latter course has seemed most~~ ^{valid and most practical}. The latter decision seemed ~~most valid~~ ^{most valid}.



New Zealand specimen
 8.15.66
 reconstructed



Restoration by Stuart Weller
of "Pseudodontomistrid type" of skull
Not affixed by H without
revision and not used in paper.

7.29.66 Noteworthy characters of New Zealand fossil

Palatines enormous, swollen

Palatine posterior end immediately ventral to anterior edge of orbit
[Compare with more posterior position in pelican (center of orbit) and Booby (posterior edge of orbit)]
Close to albatross - only slightly back of anterior edge of orbit,

Palatines not fused in midline [different from Pelican and Booby where they are fused]

Palatines at anterior tips narrowing and seemingly thrust together in midline with maxilla (or maxillopalatines) lateral to them not between them

Large rounded ridge along center of rostrum (ventrally) is it maxillary? Ridge is solid, ventrally, no perforation, but in cross section is "spongy."

Dorsally - Rostrum; in spite of straight transverse frontonasal suture, nasal process of premaxilla as well as anterior to suture - as in albatross [but not in pelican or Booby]

Posterolateral contour of rostrum, ^{slightly} convex posteriorly. Other sps. compared have concave posterior border

Lacrymal seems to be fused with frontal as in pelican
Lower Mandible "tongue-and-groove" sutures

Small points of bony teeth occur in upper jaw practically to posteriormost edge, and in lower jaw immediately anterior to large suture [These areas do not show in Pseudodonta]

61 mm of lower jaw: 2 large & 4 or 5 small on ridge "1 med & 2 "spurs" but two space between 17. to lower) 3 small with another 3 or 4 tiny above

Teeth most like valley specimens in slenderness

Distinguished from *Osteodontomys oriz*

- ① More slender lower mandible, partially brought about by more marked up. curve of lower border, but also height at suture less. (43.8 vs. 50.0 mm),
- ② Postero-lateral margin of rostrum smoothly and broadly convex in posterior outline,
- ③ Distance from anterior border of orbit to fronto-nasal suture greater (24.0 mm vs 16.0 mm).
- ④ Breadth across fronto-nasal suture greater (34 vs 27 mm)
- ⑤ Rostrum less deep in vertical dimension (40.6 vs 44 mm) posteriorly and narrowing more rapidly anteriorly (depth at broken end 73% of depth posteriorly compared to 85% difference from posterior end to level of nares in *O. oriz*). This is more suggestive of the skull of *Pseudodontomys longicaudus* which, though generally larger heavier skull than *O. oriz* has a relatively shallower beak.
- ⑥ Although the occurrence of supernumerary teeth between the large teeth is suggestive of the condition in *O. oriz* rather than *Pseudodontomys*, the actual arrangement is not identical and the teeth are more slender. In 60 mm. of lower jaw there are 8 well marked projections, the largest of which measures 14.3 mm high x 5.7 mm. at the base. This tooth is probably not comparable to the largest lower tooth in *O. oriz* but posterior to it.
- ⑦ Distance of lower suture from ventral border just back of tallest tooth, 10.8 mm (12.2 mm in *O. oriz*?). It is not distinguishable back to the suture as it is in *O. oriz*

Osteodontornis orri

revised

The unusual palatal structure characteristic of the New Zealand skull and the type of P. longirostris can be postulated in O. orri by reason of the small, swollen area ^{beneath the tomium} that can be seen in lateral view posterior to the nares, but no details can be compared. The high process of the lower jaw is clearly comparable and a flat, straight area on the dorsal edge of the suture in the type of O. orri likely corresponds with the surangular(?) noted in the New Zealand specimen. Although the teeth appear heavier in O. orri, they resemble those of the New Zealand bird in arrangement, in the presence of small processes and spines.

^{between the NZ bird & O. orri}
 Distinctions noted ^{lie} particularly in the posterior contour of the rostrum and its relationship to the frontals and lachrymals. The preorbital vacuity is shorter in O. orri, the posterior edge of the lachrymal being only 15.3 mm. behind the frontonasal suture (in contrast with 18 mm. in the New Zealand bird). The contour of the rostrum ^{in O. orri} lacks the evenly rounded convex posterior border, and the frontonasal suture is narrower (27 mm. as compared with 35 mm.). This shortening and narrowing in the frontonasal area of O. orri is particularly significant in view of the fact that on the whole the California skull has a larger, heavier rostrum and jaws. Comparable measurements on the type of O. orri and on the New Zealand specimen indicate about 10 per cent greater size for O. orri.

	N. Z.	O. orri
Depth lower jaw at suture	43.8	50
Ht "coronoid process"	50	56
Ht rostrum posteriorly	40.6	47
Ht rostrum at nares	*30	40

*slightly posterior to where nares would have been located if present

incomplete



M

6
revised
Copied

Greatest distinction between the specimen at hand and the type of *P. longirostris* is to be found in the tooth processes. Although the processes cannot be exactly compared because those of *P. longirostris* are anterior to those preserved in the New Zealand skull, the suggestion is strong that ^{not} only were all the processes more slender in the latter specimen, but there were more supernumerary processes and spines.

The present specimen appears to be at least 10 per cent smaller than the type of *P. longirostris*. It is, however, difficult to show the size by comparable measurements. With the exception of greatest depth of the palatines, (40 mm. in *P. longirostris*, 36 mm. in the present specimen), none of the measurements provided by either Spulski or Lambrecht for *P. longirostris* can be duplicated precisely in the New Zealand skull. From Lambrecht's illustrations estimates can be made of dimensions more nearly comparable to the areas present in this skull. We know, for example, that the lower jaw in these birds narrows in its anterior extent. It is significant, therefore, to find that the depth of the New Zealand jaw at its broken tip is 24.7 mm., and that this same measurement occurs considerably farther forward in the jaw of *P. longirostris* (see Lambrecht, 1930, pl. 2, fig. 2). Similarly the rostrum tends to narrow anteriorly, both in height and breadth; the breadth at the broken end in the New Zealand specimen is 45 mm., and at a point possibly slightly anterior as seen in Lambrecht's pl. 2, fig. 1 the estimated breadth is 55 mm. The height at the broken tip in the former specimen is 30 mm., whereas the height in *P. longirostris* and about this same point on Lambrecht's Pl 1, fig. 1 is estimated to be 36 mm.

Lacrimal

The lacrimal bones are fused to the frontals. That of the right side has been revealed in some detail by preparation and extends roughly 33 mm. below the dorsal surface at a point 20 mm. posterior to the frontonasal suture. Characters are as follows: midway of its ventral descent, the bone broadens abruptly laterally, its outer border turning slightly upwards and posteriorly; dimensions at this point are 12.0 mm. (breadth) x 8.4 mm. (anteroposterior depth), above this point dimensions are 7.2 mm. x 6.0 mm.; bone becomes thinner anteroposteriorly as it descends but continues to flare outwardly to a lateral dimension of 17.5 mm., the ventral border descending slightly to a pointed lateral tip; the median border is straight and there is no evidence of connection to the interorbital septum; the bone appears devoid of foramina.

Zygomatic Arch

The zygomatic arch on the right side is complete in contours for a distance of 65.5 mm. from its connection with the rostrum; that of the left side is less well preserved. Characters are as follows: *a heavy bar 5-6 mm thick, roughly in line with 7 mm.* relatively narrow at connection with rostrum (~~7 mm. high~~) expanding upwards to ^{14.0}~~13.5~~ mm. immediately anterior to lacrimal; external surface flat, with longitudinal groove (apparently a continuation from the ~~zygomatic~~ *rostrum*) near ventral edge; dorsal edge ^{sloping} expanded inwards to form an obliquely thickened surface similar to that found in Sula.

Interorbital Area

not in final version
~~A small portion of the interorbital septum and adjacent para-~~
 sphenoidal rostrum, from its anterior tip to the point of contact with ^{together with a small portion of the interorbital septum} the pterygoids (an extent of 35 mm.) is preserved, ^{the} Fragments of pterygoids remain attached, but articular surfaces are broken. The border of the septum recedes posteriorly from the level of the frontonasal suture and forms a backward-directed, well-rounded curve before joining the forward-extended point of the parasphenoidal rostrum.

Discussion (written by Stuart Water)

14

The Order Pelecaniformes is well known as a relatively heterogeneous assemblage of birds. Skulls representative of the various families reflect this heterogeneity. The most outstanding characters typical of the order are obsolescent nares (except Phaethon), united palatines (except Phaethon), and a straight, well-developed craniofacial or frontonasal hinge (least developed in Fregata). The osteology of the Pelecaniformes has been described by Shufeldt (1902).

Knowledge gained of the preserved portion of the P. stirtoni skull, added ^{considerably to what was known previously of the pseudodontornithid skull as revealed in} to that already known of the skulls of

^{As types of} P. longirostris and Osteodontornis orri, provides sufficient ^{Combining the details revealed in the three specimens it is possible to achieve some} information of the nature of the pseudodontornithid skull to ^{allow some significant} comparisons with skulls representative of ^{other} families ^{of birds} of pelecaniform birds. Figure is a reconstruction of a Pseudodontornis-like skull combining features of P. stirtoni and P. longirostris.

In overall configuration the pseudodontornithid type of skull resembles most that of Pelecanus erythrorhynchos ^{particularly P.} (fig.).

The long bill, relatively short postorbital ~~portion~~ ^{and forward sloping quadrates} portion of the cranium, long mastoid processes, and descending palatines, are points of similarity. In Pelecanus occidentalis the ~~quadrates are long and rotated forwards.~~

^{The intranasal} ^{is} Two other outstanding features of the pseudodontornithid skull ^{are} found represented elsewhere among the Pelecaniformes only in sulid skulls. (One is the massive zygomatic arch, ^{more massive inferior} which is, however, not contacted by a massive lacrimal, as it

is in Sula. The second feature is that of the well-developed intraramal hinge, located more anteriorly in Pseudodontornis than in Sula.

no 4 The mandibular rami of modern pelecaniform birds are sufficiently slender (Pelecanus) or compressed (all others, except Sula) to allow sufficient bending for widening of the gape. The solid mandible is inflated to the point that the bone is inflexible except at the intraramal hinges and mandibular symphysis. A fresh specimen of Sula neboxii was made available through the courtesy of Dr. Kenneth Stager and Mr. James Northern of the Los Angeles County Museum of Natural History. Manipulation of the jaw of this specimen allowed an expansion of the intraramal distance at the level of the hinges from 12mm (relaxed) to 35 mm -- an expansion of nearly 200% -- without the exertion of undue force. The presence of similar hinges in the massive pseudodontornithid mandible implies a similar "expandability" of the gape in these birds.

The palatines in all modern pelecaniforms, although united posteriorly (except Phaethon), are separate anteriorly, forming a rather broad area of fusion with the premaxillary mass. At this end the palatines (prepalatine processes) are invariably ^{discreetly flattened} depressed and bending occurs here within the palatines upon movement of the upper jaw. The ^{thickened} Pseudodontornis palatines ^{as now revealed in P. stictorni} differ in that, although there is no visible evidence of fusion, they remain adjacent along their entire length, narrowing almost to a point anteriorly, ^{and passing together} where they pass into the ^{maxillary} prepalatine mass, where they may be ^{in the} hinged as are the palatines of Pelecaniformes.

beavers of the
The ~~mandible~~ ^{mandible} is notched, i.e., the condition found in Sula, with
of all Pelecaniformes has the stoutest and.

The presence of a femur associated with the skull of P. stirtoni ^{has} made possible comparison with the type femur of Palaeochenoides mioceanus and suggests that the listing of Pseudodontornis and Palaeochenoides in separate suborders (Brodkorb, 1963) is justified. Parallelling the relationship to Recent pelecaniform and procellariiform birds shown in the skull and gross contours of the limb bones of Osteodontornis orri (Howard, 1957:20) the New Zealand femur shows a combination of albatrosslike and pelecanlike characters. the Palaeochenoides femur is more distinctly pelecaniform.

In Hopson's study (1966) of fossils from the ^{Miocene} Hawthorne formation of South Carolina, he assigned a tarsometatarsus (Mus. Comparative Zoology no. 2514) to Palaeochenoides mioceanus, largely on the basis of its general agreement in size to the type femur of that species from the same formation. He noted, however, the albatrosslike qualities of the tarsometatarsus as distinguished from the pelecaniform characters of the femur. In the same formation he found a Pseudodontornithid lower jaw which he assigned to Pseudodontornis longirostris. These occurrences logically led to his raising the question of the possible synonymy of Palaeochenoides and Pseudodontornis (the former having priority). The present study not only indicates that the genera are properly distinct, but suggests that the ~~tarsometatarsus~~ ^{tarsometatarsus} MCZ 2514 more likely relates to the Pseudodontornis jaw than to the Palaeochenoides femur.

sharply rounded

temporal fossae widely separated

* angle of mandible truncated

humerus has ectepicondylar process

skull has supraorbital grooves (separated by wide bar)

femur shorter & more curved than tibia

Discussion

In describing the New Zealand bird as a species of the genus Pseudodontornis, we have chosen the one, of three possible decisions, that seems to us both practical and valid. As we have indicated above (ms pp 3-5) characters significant in comparison with one of the previously described genotypes (Pseudodontornis longirostris and Osteodontornis ovi) cannot be checked on the other, and the generic distinctions between Pseudodontornis and Osteodontornis previously enumerated (Howard, 1957:3) are not clearly indicated on P. shirtoni. Even the similarities to Pseudodontornis, striking though they appear to be, would be open to question, did we not assume that Lambrecht's statement regarding ^{median} united palatines in P. longirostris was based on incomplete preparation of the specimen.

Three possible decisions could be made with regard to the New Zealand bird: (1) its differences from ^{both} Pseudodontornis longirostris and Osteodontornis ovi were sufficiently distinct to be of generic value; (2) its differences from ^{both} the other two forms were ^{so} greater than specific value and all three represent ^{separate species} one genus (which by rule must would be Pseudodontornis); (3) its differences from Osteodontornis ovi were more marked and similarities to Pseudodontornis significant, and it should be considered a distinct species of the latter genus. The latter decision seemed to us most valid.

The longitudinal sulcus on both upper & lower mandibles is noted for both *P. longi* & *O. ori*, but the precise area represented in the NZ skull shows only in *O. ori*. That of the lower jaw in *O. ori* extends ^{whereas in the specimen at hand} is clearly observable to the suture, ^{it seems to} stage anterior to the suture is ~~the same specimen~~ at hand. The vertically high zygomatic arch is notable in both *P. longi* & *O. ori*. The Sculpture of the dorsal edge of the lower jaw posteriorly is shown in the illustration of *P. longi* (Lambrecht 1930 pl. 1, fig. 2) but is not discussed. Lambrecht does, however, state that there is no mandibular foramen. On the skull at hand the dorsal depression on the inner side of the mandible deepens anterior and forms what we interpret to be the mandibular foramen; this area ~~is~~ is obscured by matrix in *P. longi*.

The most striking comparison can be made with *P. longirostris* in the palatal region. The large rounded central ridge on the ventral side of the ~~palatine~~ ^{enlarged} palatines ~~illustrated by~~ ^{illustrated by} Lambrecht (1930 pl. 1, fig. 2) are markedly like the ~~condition found in~~ ^{condition found in} this NZ skull. Lambrecht's description, however, indicates that the ~~palatine~~ ^{palatines} of left & right side are medially united. As the matrix in *P. longi* was not completely cleared in the palatal area, it is possible that division of the palatines was obscured. Lambrecht further inferred (1930:5) that the maxillopalatines were visible and "separated by a cleft in the middle line." Again because of the adherent matrix, we believe that Lambrecht may have mistaken the anterior continuation of the palatines for maxillopalatines. It is highly unusual to find the palatines so medially situated & only by a small increase in the entire length of the bones can they be properly interpreted.

A sulcus below the termination of the upper and in *O. ori* suggested the presence of the enlarged median ventral ridge, but the palatal area cannot be studied.

the fortunate association of the femur with
the skull of The New Zealand form, enables us
to clarify the question of the relationship
of Pseudodontornis to Palaeochenoides. Hapson
(1964) recorded ^{a jaw of a bony-toothed bird from the phosphate beds of So Carolina} Palaeochenoides ^{minimally from the type locality} ~~and assigned~~
it to Pseudodontornis longirostris. At the same time

he recorded a distal end of a large tarsometatarsus also
from the phosphate beds, but in the Ashley River. ~~Thus he tentatively assigned it to Palaeochenoides~~
P. miocenus on the basis of its size in proportion to the
type femur of that species. He noted, however (p. 16),
that whereas the femur of Palaeochenoides is distinctly
pelicaniform in character, the tarsometatarsus
~~is~~ more closely resembles the Procellariiformes.
~~He further concluded from this~~ ^{noted} ~~that as a~~
~~combination of~~ ^{characters} ~~had been ascribed to the family~~
Pseudodontornitidae by Howard (1957) and suggested
that the possibility that Palaeochenoides
Pseudodontornis ^{might actually be a synonym of} Palaeochenoides
^(Shufeldt 1916) ~~(Shufeldt 1930)~~.

The distinguishing between
stutoni & that of Palaeochenoides miocenus
have been noted above (pp 11-12), ~~where~~
~~character~~ and it is significant to note ~~that the~~
~~close similarity of P. stutoni~~ ^{the former shows the}
same general relationship to recent living ^{procellariiform} ~~birds~~
by Hapson in the So Carolina tarsus.

Discussion

Regarding the ordinal relationship of the bony-toothed birds, the present specimen adds little to what has already been observed. Howard (1957) following Spulski (1910) has contended that they represent a distinct order, exhibiting characters of both the Procellariiformes and the Pelecaniformes. Wetmore (1960:8) on the other hand, after careful analysis of the Eocene representative of the group, Odontopteryx toliapicus felt that relationship with the Pelecaniformes was more strongly indicated and recommended a subordinal position within that group. Howard and White (1961) ~~xxxxxxxf~~ ^{observation that} an atlas vertebra associated with the bony-toothed jaw from Canoga Park, Los Angeles County, Calif., exhibited pelecaniform characters, added weight to Wetmore's conclusion.

In the New Zealand skull, the fusion of the lacrimals to the frontals as in Pelecanus, is very evident, also a smooth supraorbital area, lacking fossae is suggested, although the actual orbital area is lacking. The frontonasal hinge, while seemingly straight, as in the Pelecaniformes, shows the paired nasal processes of the premaxillae both posterior and anterior to the hinge, a condition not seen in any of the living pelecaniform birds examined but observed in albatrosses, petrels, shearwaters, etc. The straight mandibular suture, with tongue and groove flexibility is suggestive of the condition in *Sula*; its position well anterior to the orbit is, however, distinct from other birds compared, as is also the high pseudocoronoid process.

Regarding the relationship of the Bony-toothed birds to existing ^{divian} orders, the New Zealand specimen contributes three points of evidence based on ^{characters} ~~details~~ not observable in detail on other representatives of the group.

- ① ~~The rostrum in cross section is spongy and porous, but has no ^{rights} distinct nasal canals. This ^{may be construed} as a peleciform character.~~
- ② The palatine bones are greatly inflated, separated medially and set close together at their junction with the premaxillae. A combination of characters ^{not found in} any group of living birds.
- ③ General contours of femur suggest ~~mass~~ lack of pneumaticity and certain similarity to Diomedea.
- ④ It is strongly suggested ^{normally that} ~~that the~~ external nares were present but that they were functional and opened into a medial nasal cavity. ~~Of course this is not a peleciform character.~~
- ⑤ The ^{straight} mandibular suture ^{with tongue + some flexibility} ~~abnormally~~ ^{well} ~~aligned~~ ^{anterior} to the orbit. ~~Expansion of the jaws and is suggestive of that of Sula;~~ ^{as is also} ~~its position is, however,~~ ^{enlarged high} ~~is distinct from other genera compared; the~~ ^{distinctive}

In this skull as in that of P. longi + O. ori the combination of characters ^{does} ~~not~~ place it well in any living order. The earlier genus Stycolonyglenx, has, however, been conclusively placed in the Peleciformes. ^{either the} ~~the~~ ^{original} ~~the~~ ^{actual} ~~the~~ ^{stock} or we have diverged widely from ~~the~~ ^{its} ~~the~~ ^{original} ~~the~~ ^{stock} or we are dealing with parallel evolution of ~~the~~ ^{the} bony teeth.

Pseudodentornis Charadriidae of Bony tooties birds
Sambrecht says

7.29.06

New Zealand

Spulski says of
Pseudodentornis
"The orbits were not
separated by bone but
probably only divided
by a membrane"

Pterygoid rests on
basipharyngeal and
in middle articulates
with palatal bone with
an articular groove

Palatines are unusually
large. Posteriorly have
simply formed articular
heads. They rest in an
upward & backward directed
groove.

Palatines are perpendicular
Ventral surface forms a
ventrally directed somewhat
compressed angle. Above
this angle the height of the
palatines is 40 mm., while
at the posterior end the height
is only 10 mm.

Coossification of facial bones
so complete that separating
nasals, internasals & maxillae
is impossible

Depression on dorsal side of posterior part of
lateral groove begins at posterior of eye
arcade & runs then runs straight

front-nasal suture
straight

well developed bony ridge
stretches from tip of rostrum
to anterior end of palatines
becoming thicker posteriorly

same?

Maxillopalatines separated
by a chink in middle line

← Check This

Dorsal view, upper mandible
divided in 3 by 2 long furrows
Middle = premaxilla
+ the maxilla
Two lateral = maxillae & side branches
to premax. (cf. Pelican & P. collaris fens)

← same?

Note lower teeth in NZ fossils
are presumably equivalent to smaller
teeth of P. orri (posterior to the max. teeth
3rd from back 5.9, 6.0 base (O. orri 5.8)

Measurement of lacrimal

- ① Dorsal surface of frontop
to tip of lacrimal 33.3 mm
- ② Dorsal surface frontop
to 'shelf' 17.2
- ③ Lateral dimension
above shelf 7.2
- ④ Greatest lateral
dimension below shelf 17.5
- ⑤ Lat. dimension thru
the 'shelf' 12.5
- ⑥ Depth from 'shelf'
to ventral tip 16.8
- ⑦ Ant. post dimension
of 'shelf' 8.6

New Zealand Skull
1st meas. of lacrimal

	Pseudo long	N. 2	O. ori	Valley	So. cave.
Gr. ht. of palate	40 mm	35?	—		
ht of palate at its post end.	10 mm.	7?	—		
naris to orbit	110	?	108.8?		
naris to nostril hinge	90	68.8 slight of base	93		
hinge to orbit ant. end of frag.	20	20.7?	15.8?		
Jaw ht.	18	—	16.2?		18?
Jaw ht back of posterior most tooth in frag.	29.5	even post to this not more than 24	29.6	29.0	—
Jaw ht back of interned. tooth bet. ant. 1 & 2	19.1	—	16.5?		19.8
Jaw ht at suture	45.4?	43.0	50.0		
Jaw ht ant to 3rd tooth	26.4		25.7?	26.4	
Jaw ht at coronoid	53.3?	46.8?	56.0		
Depth beak at center of naris	36 (38)	post. to naris 32.0	40.		
Ht zygoma	17?	13.2	13		
depth mandible posterior to coronoid	31.6 33.6	26.9	29.4		
Depth beak at hinge	?	(gr. depth) 40.3+	40.7		
Gr. hinge (fronto-nasal)	?	33.8	28.5 27. (pub.)		
depth mandible ant to suture at nasomaxilla	?	25.8	37.6		

43.05, 39.5 9170

39 32.5 9690

40-28

41.5

178.8

146.3 length jawfrag
of *Pseudo. longi*.

76.3 length of same
frag as illis
Tap. 1 fig. 1

7.29.66

Measurements (mm) and proportions (ratios in %) of Bony-toothed Fossil Birds

1966

	Breadth fronto-nasal suture			Distance from post edge lacrima to fronto-nasal suture	Distance from dorsal edge suture to spine of mandible & suture of fronto-nasal suture	Height of nostril in mandible & suture of fronto-nasal suture	Height of zygomatic	Height lower jaw at suture	greatest ht palatine	Height at posterior end of palatine	probable length of mandible	distance of nares from orbit	distance of nares from fronto- nasal suture	Height at posterior most tooth (upper)	Length of palatine tooth (upper) at base	space between large teeth from center of each tooth	distance of teeth from base	thickness of palatine
<i>C. oviri</i>	280	(27.0 ratio)		19.5	28.2		13.0 ⁺	50.0			300		93			21.3 post 49.4 ant		
<i>N. Zealand fossil</i>	32.0			21.6	28.5	40.8	14.0 ^{pt}	43.4	24.27	10?						21.1		18.0
<i>Pseudodontornis</i>	26.5 [?]			20.0	—	40?	17.5	45.4	40.0	10.0	400mm	110	90	17.0	15.0	ant/ht 50.0	1420mm 10 ht	21.0

To be read at Cooper Soc. Annual in La Barbara
April 7 or 8, by * author.

A NEW ZEALAND RELATIVE OF
CALIFORNIA'S FOSSIL BONY-TOOTHED BIRD

By

Hildegarde Howard and Stuart L. Warter*

Another paper
(same title) same
author(s)
was presented at
So. Calif Acad
May 6, 1947
by Howard

^{Now}
A partial skull with associated jaws, representing
a relative of California's fossil "bony-toothed" marine
bird, Osteodontornis, has been found in New Zealand.
The specimen was contained in one of the numerous
calcareous concretions found along Motunau Beach, about
35 miles north of Christchurch, and is presumed to be
of Pliocene age. Hence it is somewhat less ancient
than the California bird, which comes from Miocene deposits.
Through the courtesy of Dr. D. R. Gregg, of the Canterbury
Museum, the specimen is on loan to the Los Angeles County Museum
of Natural History for our study.

The New Zealand specimen is the seventh reported
occurrence representing this curious group of birds in which
both upper and lower jaws bore bony, toothlike projections
in somewhat regular arrangement. The earliest occurrence
was from the Eocene of England; others (as far as locality
and age are known) are from the Miocene of the west and east
coasts of the United States. Unfortunately, the source of the
type of the genus Pseudodontornis, which the New Zealand
specimen seems most closely to resemble, has never been
ascertained.

Although no living group of birds possesses the remarkable adaptation of bony teeth, other characters of the skull have led to the placement of the group in the Order Pelecaniformes, but as a separate, extinct suborder (Odontopterygia). Two families are recognized: one (Odontopterygidae) containing only the genus *Odontopteryx*, the Eocene representative; the other (Pseudodontornithidae) known from two genera, Osteodontornis and Pseudodontornis. The New Zealand bird is assigned to the latter genus, and will be described as a "new" species.

All specimens of the bony-toothed birds so far recorded are incompletely preserved. The remarkable specimen of Osteodontornis orri, which may be seen exhibited here at the Santa Barbara Museum of Natural History, presents the greater part of the skeleton, and reveals the general proportions of the bird -- long, slender wing bones, short legs, heavy, long-billed, "toothed" skull with slitlike external nares not quite halfway from the hinge to the tip. However, very little detail of structure can be discerned, especially in the crucial areas of the skull concerned with the functioning of the jaws. The type of the genus Pseudodontornis, P. longirostris, presents only the incomplete skull and jaws, though actually more of them than in the New Zealand specimen. But again, crucial details are obscure. All other records of pseudodontornithids are based on jaw fragments bearing tooth processes. In the New Zealand skull, as prepared by

Leonard Bessom of the Los Angeles County Museum of Natural History, the lacrimal and the full length of the palatine bones have been revealed, as well as the suture between the cranial portion of the skull and the beak, and the intraramal suture of the lower mandible.

Combining these details now revealed with such characters as can be seen in the type specimens of Osteodontornis and Pseudodontornis (particularly the length of the beak and position of the quadrates), it is possible to make some significant comparisons with skulls representative of families of living pelecaniform birds.

The Order Pelecaniformes is well known as a heterogeneous assemblage, and the skulls representative of the various families reflect this heterogeneity. The most outstanding skull characters typical of the order are reduced or obsolete nares (except in ^{torquatus} Phaethon), united palatines (except in Phaethon), and straight craniofacial hinge (least developed in Fregata).

In overall configuration, the pseudodontornithid type of skull most nearly resembles that of Pelecanus. The long bill, relatively short postorbital portion of the cranium, long mastoid processes and forward sloping quadrates are points of similarity, as well as a straight craniofacial hinge. In matters of detail, however, distinctions are marked. These distinctions are largely associated with the most notable character of the fossil group, the bony tooth processes, which are concomitant

with a generally heavier skull. The slender, flexible lower mandible of Pelecanus, is replaced in the fossils with very heavy ^{thickened symmetrical} rami. The rostrum, too, is heavier, as are the zygomatic arches and the palatine bones. Whether or not the aperture on the rostrum was functional as an external naris is yet to be determined.

The character of the lower jaw can be more closely identified with the condition found in the boobies and gannets than in the pelicans or any other pelecaniform bird. In Sula flexibility is achieved by an intraramal hinge. Through the courtesy of Dr. Kenneth Stager and Mr. James Northern of the Los Angeles County Museum of Natural History, a fresh specimen of Sula neboxii was made available for study. Manipulation of the jaws of this specimen allowed expansion at the level of the intraramal hinges of nearly 200 per cent (from a breadth of 12 mm., relaxed, to 35 mm., expanded), without exertion of undue force. The intraramal suture as revealed in the New Zealand fossil, like that of Sula, is a hingelike joint, and, as it appears to lack a connecting bone at the lower contour, may have been even more expandible than in the living sulids.

In the structure of the palatines and the matter of mobility between these bones and the rostrum, there is no member of the Pelecaniformes with which to compare the fossil group. The palatines in all modern pelecaniforms,

although posteriorly united (except in Phaethon), are widely separate anteriorly, ^{where they} ~~forming a rather broad area of fusion~~ with the premaxillary mass. At this ^{point of fusion} ~~end~~ the palatines (prepalatine processes) are invariably dorsoventrally flattened, and bending occurs here within the palatines upon movement of the upper jaw. The thickened Pseudodontornis palatines, as now revealed, ^{in the N2 skull} lack this flexibility. Although there is no visible evidence of ^{union of the R & L palatines} ~~fusion~~, they remain adjacent along their entire length, narrowing ^{anteriorly} almost to a point ^{laterally} ~~but deep dorsoventrally and~~ ^{anteriorly} ~~anteriorly and~~ passing together into a greatly enlarged central premaxillary ridge, where they may be hinged as are the palatines in the parrots.

We find, therefore, that although the pseudodontornithid skull type presents in varying degrees a number of similarities to living pelecaniforms, its singular combination of features, plus its own unique characteristics, set these bony-toothed birds apart from all other pelecaniform types. The intraramal hinges present in the fossils and in sulids probably represent independently acquired convergent features adapted to allow significant mobility within an otherwise "inexpandible" jaw. The similarities in conformation between pseudodontorn and pelecanid skulls may represent either parallel evolution from, or convergent evolution toward a long-billed skull type.

To Stage 3.22.67

A New Zealand Relating
California Fossil Bony-toothed Bird
By
Hildegarde Howarth & Stuart A. Walter*

A partial avian skull and associated jaws found in a Tertiary concretion on the beach near Christchurch, New Zealand, proves to be related to *Osteodontornis*, the Miocene marine bird of California characterized by the presence of large bony, toothlike projections on the jaws. Other members of this extinct suborder (*Odontopterygidae*: Order *Pelecaniformes*) have been recorded from eastern United States and Europe. The New Zealand specimen, on loan to the Los Angeles County Museum of Natural History from the Canterbury Museum, has been prepared so as to reveal characters of the jaws and palatal area in greater detail than were heretofore known. It has, therefore, been possible to draw more definite conclusions regarding the function of the jaw mechanism in these extinct long-billed, "toothed" jawed birds in comparison with living peleceniforms.

Further observations on the fossil
Bony-toothed birds, based on a record from New Zealand

Presented at COC by Walter

Vertebrates of the U. S.

Blair, Blair, Brodskort, Capill &
McGraw Hill 1957 Moore

Palmer's Handbook of N. Amer. Birds.

Pelecaniformes p. 359

totipalmate swimmers. Bill long, with complex
rhamphotheca; notches strong or even without ext.
genuis; gular pouch present. Wings large; function
primaries 11, secondaries 16-20, aquilto cubital; alulae
absent; mature downe nearly all over body; oil gland tufted.
Legs short; tarsi reticulate; feet totipalmate.

Palate desmagnathous, without basipterygoid processes.
Holohermal. Base of mandible blunt; cervical 15-20.
Sternum without internal spine, ext. spine small; keel
produced forward. Hypotarsus complex with several canals.
No supraorbital glands. Tongue rudimentary; proventriculus
large; intestine type 2, caeca small. Syrinx tracheobronchial
Thigh muscles $A(XY) +$; toe tendons type 2; 1 pair tracheosternus
muscle.

desmagnathous
maxillalatines fused in midline
vomer small or lacking

Dato for Paper
(with Stuart Warren)

Records Canterbury Mus.

VIII (4); 345-357

1969